Pomological and Biochemical Characterization of Two Turkish Almond Cultivars Grown in the Anatolia Region

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Abstract

This study was carried out to determine some pomological and biochemical properties of two Turkish local almond cultivars ('Gölbasi I' and 'Gölbasi II'), compared with four commercial ones ('Ferragnès', 'Ferraduel', 'Nonpareil' and 'Yaltinskij') of different origins and grown in the Anatolia region of Turkey. The kernels were used to determine proteins, total oil, fatty acids, sugar profile, macro and micro mineral elements. The highest protein content was found on 'Ferragnès', followed by 'Gölbasi I' and 'Ferraduel'. It was intermediate on 'Gölbasi II' and 'Yaltinskij', and lower in 'Nonpareil'. Differences in mono-unsaturated (mainly oleic and linoleic) and saturated (palmitic and stearic) fatty acid contents were found among cultivars. The content of oleic acid in 'Gölbasi I' and 'Gölbasi II' was similar to that of 'Ferraduel' and 'Ferragnès', having all of them higher contents than 'Nonpareil' and 'Yaltinskij'. In contrast, the contents of linoleic and palmitic acids in 'Nonpareil' and 'Yaltinskij' were higher than those from the other four cultivars. There were also significant differences among cultivars for soluble and total sugars, and macro- (mainly P, K and Mg) and micronutrient (Mn, Zn and Cu) contents.

INTRODUCTION

The aim of the present work was to study six commercial and local almond cultivars by measuring their content of total oil and protein and their composition of sugars, fatty acids (palmitic, palmitoleic, stearic, oleic, and linoleic acids), macro- and micronutrients. All components are primarily dependent on the almond genotype, but are also influenced by factors such as the growing region, the ecological conditions or the technical and cultural practices (Balta et al., 2009). Some studies showed a significant accumulation of Ca, Cu, Fe, K, P, Mg, Mn, and Zn in the kernel during fruit growth and ripening with concomitant losses from the shell (Yada et al., 2011).

MATERIAL AND METHODS

Plant Material

The two Turkish cultivars ('Gölbasi I' and 'Gölbasi II') were compared with four commercial cultivars: 'Ferraduel' and 'Ferragnès' from France, 'Yaltinskij' from Russia and 'Nonpareil' from USA. They were grown in two fields in the Anatolia region with typical growing conditions for this area. Morphological analyses included nut and kernel

weight, as well as nut lenght, width and diameter. Shelling and double kernels were also determined.

Macro- and micro-element and sugar analysis

Sixty seeds from each almond cultivar were randomly selected. Biochemical analyses were carried out at the Experimental Station of Aula Dei (CSIC) and Agroambiental Laboratory (Local Govern of Aragon) in Saragossa. The mineral element composition of the dried tissue was measured as previously reported (Jiménez et al., 2007). Sugars analysis was performed by high performance liquid chromatography (HPLC) of the fresh samples as described by Jiménez et al. (2011).

Protein and oil analysis

The protein content was determined by the Dumas method, according to the rate of total nitrogen (Font i Forcada et al., 2011a). The fat content was determined as the difference in weight of the dried kernel sample before and after extraction (Kodak and Socias i Company, 2008).

Fatty acid composition

The oil sample was utilized to prepare the methyl esters of the corresponding fatty acids (FAME) according to the EU official method (EEC Regulation 2568/91). The identification of the FAMEs was made by standard methyl esters (Sigma, Aldrich, Madrid, Spain) (Kodak and Socias i Company, 2008).

Data analysis

Data were analyzed statistically using SPSS 19.0 (SPSS, Inc, Chicago, USA). Data were evaluated by two-way variance (ANOVA) analysis. When the F test was significant, means were separated by Duncan's multiple range ($P \leq 0.05$).

RESULTS AND DISCUSSION

The Gölbasi cultivars showed higher twin seed percentage than the other commercial cultivars (Table 1). The highest fruit weigh was obtained in 'Gölbasi I', 'Ferragnès' and 'Ferraduel'. Higher content of mineral elements were in general shown on 'Ferragnès' and 'Ferraduel', although 'Gölbasi I' did not significantly differ from them in several elements (P, K, Mn and Na). The highest Mn content was found in 'Nonpareil' and the Cu content in 'Nonpareil' and 'Yaltinskij' (Table 2). These results are in good agreement with other authors (Piscopo et al., 2010). The highest total oil content was recorded in 'Yaltinskij' (Table 2). Differences in several European cultivars were also reported by Font i Forcada et al. (2011b). The study of fatty acid composition of these genotypes showed their low concentration of the ensemble of saturated fatty acid (SFA), palmitic and stearic (Table 3), agreeing with Özcan et al. (2011). Commercial cultivars, with the exception of 'Ferragnès', proved to have higher sucrose and total sugars contents than Gölbasi cultivars, in contrast with results reported by Barreira et al. (2010).

CONCLUSIONS

Significant differences among cultivars were shown for most macro (mainly P, K and Mg) and micro (Mn, Zn and Cu) nutrients, soluble and total sugars, as well as for pomological characteristics. The cultivar 'Gölbasi I' could be an interesting genotype due to its good adaptation to the Turkish growing conditions and its high kernel quality.

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Tables

Table 1. List of studied cultivars, origin, description and pomological properties of some commercial and local Turkish almond cultivars.

Cultivar	Origin	Nut weight (g)	Kernel weight (g)	Shelling (%)	Double kernels (%)	Nut length (mm)	Nut width (mm)	Nut diameter (mm)
Ferraduel	INRA, Fr.	5.58	1.41	25	0.0	37.42 bc	24.37 c	17.16 e
Ferragnès	INRA, Fr.	4.53	1.65	36	0.0	36.81 abc	23.15 b	16.31 d
Gölbasi I	Turkey	10.78	1.53	14	1.5	45.30 d	29.36 d	18.79 f
Gölbasi II	Turkey	4.95	0.85	17	1.7	36.45 ab	20.23 a	14.32 b
Nonpareil	USA	2.12	1.17	55	0.0	35.92 a	20.09 a	13.58 a
Yaltinskij	Ukraine	2.78	1.34	48	0.0	37.94 c	20.77 a	15.16 c

Mean separation within columns by Duncan test ($P \leq 0.05$)

Table 2. Macro and micro mineral elements and protein and total oil content of some commercial and local Turkish almond cultivars. Data for P K, Ca, Mg and Na, and protein and total oil content are expressed as percentage of dry matter and for Fe, Cu, and Mn as mg/kg of dry matter.

Cultivar	P	K	Ca	Mg	Fe	Mn	Zn	Na	Cu	Protein	Total oil
Ferraduel	0.62 c	0.8 b	0.22a	0.26 b	55.3 a	12.3 cd	45.7 c	0.08 c	11.0 ab	28.3	54.6
Ferragnès	0.60 bc	0.8 b	0.23a	0.28 c	35.7 a	9.3 ab	34.7 a	0.08 c	9.7 ab	24.6	55.9
Gölbasi I	0.62 bc	0.8 b	0.15a	0.26 b	46.7 a	12.7 cd	41.0 b	0.07 c	10.0 ab	24.8	56.7
Gölbasi II	0.47 a	0.7 a	0.17a	0.26 b	56.0 a	8.7 a	41.3 b	0.05 bc	9.3 a	20.9	55.5
Nonpareil	0.47 a	0.7 a	0.25a	0.23 a	46.7 a	14.0 d	36.0 a	0.04 ab	12.0 b	19.6	56.4
Yaltinskij	0.50 ab	0.8 a	0.27a	0.22 a	40.3 a	11.0 bc	38.3 ab	0.02 a	11.7 b	22.1	57.6

Mean separation within columns by Duncan test (P≤0.05)

Table 3. Saturated and unsaturated fatty acid contents of some commercial and local Turkish almond cultivars (%) (m/m). Acids: myristic (C-14:0); palmitic (C-16:0); heptadecenoic (C-17:0); heptadecanoic (C-17:1); stearic (C-18:0); araquidic (C-20:0); eicosenoic (C-20:1); behenic (C-22:0); lignoceric (C-24:0); palmitoleic (C-16:1): oleic (C-18:1); linoleic (C-18:2); elaidic (t-C-18:2); and t-lioleic (t-C-18:3).

Cultivar	Saturated fatty acids								
	C-14:0	C-16:0	C-17:0	C-17:1	C-18:0	C-20:0	C-20:1	C-22:0	C-24:0
Ferraduel	0.05	6.0	0.10	0.10	1.7	0.1	0.1	0.05	0.05
Ferragnès	0.05	5.4	0.05	0.01	1.4	0.1	0.1	0.05	0.05
Gölbasi I	0.05	6.1	0.10	0.10	1.6	0.1	0.1	0.05	0.05
Gölbasi II	0.05	6.0	0.05	0.01	1.6	0.1	0.1	0.05	0.05
Nonpareil	0.05	6.6	0.05	0.01	1.4	0.1	0.1	0.05	0.05
Yaltinskij	0.05	6.7	0.10	0.10	1.5	0.1	0.1	0.05	0.05

Cultivar	Unsaturated fatty acids				
	C-16:1	C-18:1	C-18:2	t-C-18:2	t-C-18:3
Ferraduel	0.6	77.4	13.9	0.05	0.05
Ferragnès	0.5	81.3	11.0	0.05	0.05
Gölbasi I	0.5	78.2	12.9	0.05	0.05
Gölbasi II	0.6	76.9	14.4	0.05	0.05
Nonpareil	0.5	70.4	20.6	0.05	0.05
Yaltinskij	0.5	68.6	22.3	0.05	0.05

Table 4. Soluble sugars content (mg/g FW) of some commercial and local Turkish almond cultivars.

Cultivar	Stachyose	Raffinose	Sucrose	Galactinol	Glucose	Fructose	Sorbitol	T. Sugars
Ferraduel	4.10 d	1.76 b	28.58 c	4.49 e	1.15 c	2.12 d	0.17 b	42.49 d
Ferragnès	1.17 a	0.80 a	22.52 a	2.19 d	0.61 b	0.56 b	0.17 b	28.01 a
Gölbasi I	2.12 bc	0.71 a	24.47 b	1.88 c	0.57 ab	0.43 a	0.17 b	30.35 b
Gölbasi II	2.26 c	3.11 c	21.96 a	1.84 c	0.52 a	0.91 c	0.13 ab	30.72 b
Nonpareil	2.06 b	3.17 c	29.49 c	1.25 a	0.51 a	0.75 c	0.09 a	37.46 c
Yaltinskij	1.98 b	1.87 b	28.96 c	1.66 b	0.57 ab	0.80 c	0.17 b	36.01 c

Mean separation within columns by Duncan test (P≤0.05)